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QUESTION BANK (DESCRIPTIVE)

Subject with Code : Detection and Estimation of Signals (16EC3811)

Course & Branch: M.Tech - DECS **Year & Sem:** I-M.Tech & II-Sem **Regulation:** R16

UNIT –I
DETECTION THEORY

1. a) Describe Maximum Likelihood Decision Criterion. (6M)
   b) Write a note on Test of Mean. (6M)

2. a) Illustrate with an example that the maximum liklelihood test does not always correspond to a single threhhold test in terms of the observation. (6M)
   b) Explain the properties to show that all ROCs associated with tests where $P\{d_2 \mid m_2\}$ is a continuous function of $P\{d_2 \mid m_1\}$. (6M)

3. a) State and explain Neymann-Pearson criterion. (8M)
   b) Mention the significance of Receiver Operating Characteristic (ROC). (4M)

4. a) Discuss Probability of Error Criterion. (8M)
   b) Prove that the probability of error criterion is identical to the maximum a posteriori (MAP) decision criterion. (4M)

5. a) Derive and explain Bayes Risk criterion. (8M)
   b) Determine the Bayes Decision rule associated with the following conditional probablilities: $p\{z \mid m_1\} = ½ e^{-|z|}$ and $p\{z \mid m_2\} = e^{-2|z|}$. (4M)

6. a) State and explain MIN-MAX Criterion. (10M)
   b) Define type-one error and type-two error. (2M)

7. a) Illustrate the use of the min-max design procedure with the following conditional Probabilities: $p(z \mid m_1) = e^{-x}$ for $z > 0$ and $p(z \mid m_2) = 2e^{-2z}$ for $z > 0$. Use the costs as $C_{11} = c_{22} = 0$, $c_{12} = 2$ and $c_{21} = 1$. (8M)
   b) Compare the different types of criteria used for simple binary decision problem. (4M)

8. a) Prove the theorem that if there exists a decision region Z_2^* such that the conditional Risks $B_1(Z_2^*)$ and $B_2(Z_2^*)$ are equal and Z_2^* is a Bayes decision region for some $P\{m_1\}$, then Z_2^* is a min-max decision region. (6M)
   b) Write a note on Receiver Operating Characteristic. (6M)

9. a) Describe the basic structure of decision and estimation problem. (4M)
   b) Discuss in detail Bayes Risk criterion. (8M)

10. a) Mention the differences between the different types of criteria used for simple binary decision problem. (4M)
    b) Discuss Probability of Error Criterion. (8M)

UNIT-II
BINARY DECISIONS – MULTIPLE OBSERVATIONS

1. a) Illustrate the concept of multiple observations with an example. (10M)
   b) Define Sufficient statistic. (2M)

2. a) Draw and explain Optimum decision device for additive Guassian noise. (8M)
   b) Examine the behavior of the optimal decision device for l = 2. (4M)

3. a) Discuss The General Gaussian Problem. (10M)
   b) What is signal-space analysis? (2M)

4. a) Determine the decision ruleif the noise is white with unit variance and the covariance matrix V is the identity matrix. (10M)
   b) What is called a whitening process? (2M)

5. a) Prove the theorem :"If f(z) is an invertible function of z, then an optimal decision rule based on $z' = f(z)$ will yield the same performance as one based on z. (6M)
   b) Show that an optimum decision rule can be viewed as a two step process. (6M)

6. a) For the zero – mean guassian random vector n, with variance matrix shown below.

   $$V = \begin{vmatrix} 2 & 2 \\ 2 & 5 \end{vmatrix}$$

   Find a linear transformation to a vector n' such that n' has independent components. (6M)
   b) State and prove the theorem of reversibility. (6M)

7. Explain the waveform observation in Additive Guassian Noise. (12M)

8. With neat diagram, discuss Integrating Optimum Receiver. (12M)

9. a) Define and draw a Matched filter receiver. (4M)
   b) Show that the Gram-Schmidt orthogonalization procedure is used to find a set of orthonormal functions such that only the first two components of the signal vectors are nonzero. (8M)

10. a) Write the effect of waveform observation with additive Guassian Noise. (8M)
    b) Mention the significance of Matched Filter Receiver. (4M)

UNIT-III
ESTIMATION THEORY

1. a) Define estimator and illustrate estimation problem with an example. (6M)
   b) State and explain Maximum-Liklelihood method of estimation. (6M)

2. a) Explain Sample mean. (6M)
   b) Discuss the Invariance of maximum-likelihood estimator. (6M)

3. a) State and derive Bayes cost method of estimation. (6M)
   b) Mention the significance of Uniform Cost Function. (6M)

4. a) Write a note on Mean Square Error criterion. (10M)
   b) Define Bayes estimation criterion. (2M)

5. a) Define and explain Absolute Value Cost Function. (6M)
   b) Describe the relationship of various types of estimators. (6M)

6. a) Mention the importance of Linear Minimum Variance Method. (2M)
   b) Derive and explain Linear Minimum Variance Method. (10M)

7. a) Discuss about Least Squares Method. (10M)
   b) Compare Linear Minimum Variance Method and Least Squares Method. (2M)

8. Explain the estimation of signal in presence of Guassian Noise with linear Observations. (12M)

9. a) Mention the significance of sequential estimation. (2M)
   b) Describe the sequential decision making to the Guassian estimation problem. (10M)

10. a) Compare three different versions of estimation in the presence of Guassian noise. (4M)
    b) Discuss the Non linear estimation in the presence of Guassian noise. Show that all non linear problems are complex by considering one dimensional example. (8M)

UNIT IV
PROPERTIES OF ESTIMATIORS

1. a) Discuss about conditionally unbiased estimation. (6M)
   b) Write the importance of unconditionally unbiased estimation. (6M)

2. a) Mention the importance of minimum variance conditionally unbiased estimators. (4M)
   b) Explain in detail The Cramer Rao bound. (8M)

3. a) Define an Efficient estimate. (2M)
   b) Describe about Asymptotic properties in estimation. (10M)

4. a) Explain Sensitivity and Error Analysis in Estimation Theory. (6M)
   b) For the scalar observation $z = \theta + n$, estimate θ if it is normal with zero mean and Variance V. Use Maximum liklelihood procedure. (6M)

5. a) What is state estimation? Mention various state estimation algorithims. (4M)
   b) Explain the formulation of the state estimation problem. (8M)

6. a) What is the importance of Kalman Filter? (2M)
   b) Describe the parameter estimation using kalman Filter. (10M)

7. a) Illustrate the Kalman filter with suitable diagram and summarize how it can be used for State estimation. (10M)
   b) What is Prediction filtering? (2M)

8. a) Explain the terms bias and efficiency of estimators. (8M)
   b) Define unconditionally simple consistent and unconditionally mean-square consistent. (4M)

9. a) Discuss briefly about Cramer-Rao lower bound with scalar parameters. (6M)
   b) Discuss the applications of Kalman Filter. (6M)

10. Design Kalman Filter with neat block diagram. Derive Kalman gain, correction and Minimum MSE. (12M)

UNIT V

SUFFICIENT STATISTICS AND STATISTICAL ESTIMATION OF PARAMETERS

1. a) Describe in detail the concept of Sufficient Statistics. (10M)
   b) State Factorization Theorem. (2M)

2. a) Explain the various types of Exponential families of distributions. (10M)
   b) Mention the importance of Poisson Distribution. (2M)

3. Discuss about Exponential families and Maximum Liklelihood estimation. (12M)

4. Write in brief about uniformly minimum variance unbiased estimation. (12M)

5. a) Define Sufficient statistics. (2M)
   b) Compare Guassian, Bernoulli and Poisson Distributions. (10M)

6. What is UMVUE? Explain its significance in estimation theory. (12M)

7. Explain how Maximum Liklelihood estimate is used to estimate a parameter from various Exponential families. (12M)

8. Describe the method of using the distribution of a sufficient and complete statistic with Uniformly minimum variance unbiased estimation. (12M)

9. Mention the different exponential families of distributions. Explain any two of them with Necessary expressions. (12M)

10. Write notes on
    a) Uniformly minimum variance unbiased estimation. (6M)
    b) Concept of Sufficient Statistics. (6M)

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